Abstracts

Abstract

T. ITOH, S. HAYASHI and K. SHIMAJI: **Wood Species Excavated from Kitashirakawa-Oiwakecho Site, Report of Investigation on Buried Cultural Properties in Kyoto University III,** Center for Archaeological Operations 139 (1985) (in Japanese)

A number of wood materials were excavated from Kitashirakawa-Oiwakecho site (Johmon era, B.C. 10–5 century) in Kyoto University, Kyoto. 58 wood specimens were microscopically identified as follows: *Torreya nucifera* (6), *Aesculus turbinata* (10), *Quercus* spp. (Subgenus Cyclobalanopsis) (9), *Acer spp.* (9), *Salix* spp. (4), *Morus* bombycis (4), *Phellodendron amurense* (4), *Aphananthe aspera* (3), *Daphniphyllum* spp. (2), *Juglans ailanthifolia* (1), *Ostrya japonica* (1), *Cercidiphyllum japonicum,* Lauraceae (1), *Cladrastis sikokiana, Actinidia arguta* (1) and *Styrax japonica* (1).

T. ITOH and K. SHIMAJI: **Tree Species of Heavy Wooden Sleighs, "Shura", Excavated from Mitsuzuka Burial Mounds,** Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No.**20**, 55 (1985) (in Japanese)

Heavy wooden sleighs, "Shura", were excavated from Mitsuzuka Burial Mounds (4–8th century) in Fujii-dera city, Osaka. 5 wooden materials including 2 wooden sleighs, 1 lever and 2 natural wood were examined microscopically. The large "Shura" was identified as *Quercus* sp. (Cyclobalanopsis), small "Shura" as *Quercus* sp. (Lepidobalanus Sect. Cerris), the lever as *Quercus* sp. (Cyclobalanopsis), and natural wood as *Pinus* sp. (Diploxylon) and *Albizzia julibrissin.*

T. ITOH and K. SHIMAJI: **Tree Growth under Controlled Environment and its Annual Rhythum, I. Shoot Growth in the Young Stage of Sugi, Karamatsu, Keyaki and Kunugi,** Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No.**20**, 1 (1985) (in Japanese)

Shoot growth of Sugi *(Cryptomeria japonica)*, Karamatsu *(Larix leptolepis)*, Keyaki *(Zelkova serrata)* and Kunugi *(Quercus acutissima)* under controlled environment (Phytotron) and its annual rhythum were examined. Sugi and Karamatsu showed continuous growth of their shoot, which means annual rhythum of both species were disturbed or disappeared. Shoot growht of Kunugi and Keyaki under long day stopped within a year. Further growth of their shoot seldom occur. Thus, it was impossible to discuss appearance and disappearance of annual rhythum in deciduous trees.

T. ITOH, R.M. O'NEIL and R.M. BROWN, Jr.: **Interference of Cell Wall Regeneration of *Boergesenia forbesii* Protoplasts by Tinopal LPW, a Fluorescent Brightening Agent,** Protoplasma **123**, 174 (1984)

Wounding cells of *Boergesenia forbesii* (Harvey) Feldmann induces the synchronous formation of numerous protoplasts which synthesize large cellulose microfibrils within 2–3 hours after wounding. The microfibrils appear to be assembled by linear terminal synthesizing complexes (TCs). TC subunits appear on both E- and P-faces of the plasma membrane, thus suggesting the occurrence of a transmembrane complex. The direction of microfibril synthesis is random during primary wall assembly and becomes ordered during secondary wall assembly. The average density of TCs during secondary wall deposition is $1.7/\mu m^2$, and the average length of the TC is 510 nm. TC organization is similar to that of *Valonia macrophysa;* however, the larger TCs of *Boergesenia* (510 nm vs. 350 nm) produce correspondingly larger microfibrils (30 nm vs. 20 nm).

The effects of a fluorescent brightening agent (FBA), Tinopal LPW, on cell wall regeneration of *Boergesenia* protoplasts was investigated. The threshold level of Tinopal LPW for interfering with microfibril assembly is 1.5 μM. At 95 μM Tinopal (for short periods up to 15 minutes), microfibril impressions have atypical spherical impressions at their termini. At longer incubations (24 hours), TCs and microfibril impressions are absent. When washed free of Tinopal, the protoplasts eventually resume normal wall assembly; however, TCs do not reappear until at least 30 minutes after the removal of Tinopal. In consideration of the presence of ordered TCs before FBA treatment, their random distribution upon recovery implies an intermediate stage of assembly or possibly *de novo* synthesis.

R.M. Brown, Jr., C.H. Haigler, J. Suttie, A.R. White, E. Roberts, C. Smith, T. Itoh and K. Cooper: **The Biosynthesis and Degradation of Cellulose,** J. Appl. Polym. Sci. **37**, 33 (1983)

Recent advancements in cellulose biogenesis are reported with the objective of providing a groundwork for continuing and future investigations. The following topics are included; alteration of cellulose assembly in *Acetobacter xylinum,* alteration of cellulose assembly by direct dyes and fluorescent brightening agents, alteration of cellulose assembly by cellulose derivatives, applications to other organisms, Role of the *Acetobacter* cell envelope in cellulose biogenesis, *Acetobacter* cellulose as a substrate for visualizing the action of cellulose, alteration of microfibril assembly in *Oocystis apiculata,* linear cellulose synthesizing complexes in *Valonia,* biosynthesis of a cellulose microfibril network by carrot protoplasts, growth of radish root hairs in substances that alter cell wall deposition, the effects of cellulose synthesis inhibitors on root hair growth, the effects of the detergent Triton X-100 on root hair growth, the effects of fluorescent brightening agents on root hair growth, cellulose biogenesis: phylogenetic considerations.

S. HAYASHI: **Identification of Excavated Wood Samples from Imazato Kurumazuka Old Tomb,** Journal of Yamashiro Historical Museum, No. 3, 55 (1985) (in Japanese)

Four woody pillars and three umbrella typed wood materials that excavated from old tomb (the 5th century) are microscopically identified to Kouyamaki (*Sciadopitys verticillata* Sieb. et Zucc.) on the whole.

S. HAYASHI and K. SHIMAJI: **List of Species Represented by Wood Specimens in the Xylarium, Wood Research Institute, Kyoto University (KYOw No. 4001–6000**, Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No. **20**, 119 (1985) (in Japanese)

Our wood collection is rapidly expanding by the exchange of authentic wood samples with institutional wood collections all over the world. Collections of domestic wood samples and their hervarium vouchers are also peoceeding extensively, and total number of our wood samples amounts to ca. 10000 at present. This list consists of the botanical names of KYOw samples No. 4001 to No. 6000 in the alphabetical order of the families, genera and species, containing 107 families, 433 genera and 924 species. Exchange is available for fairly large numbers of domestic samples. Small blocks for sectioning are also available for almost all samples.

K. KURODA and K. SHIMAJI: **Computerized System for the Management of Wood Collection,** Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No. **20** 60 (1985) (in Japanese)

A computerized system was developed and examined for management of the wood collection in our Institute. The hardware system consists of a 8 inch disk unit and a 16 bit microcomputer which is equipped with a printer and a monitor. The developed software, which is written in BASIC, manages two main parts of the wood collection: i.e. 1). file preparation according to the collection ledger (sample no., ginus & species, family, common name, origin & collector, no. of sample duplicates, herbarium vouchers, and remarks) and 2). data searches of the ledger. The former one provides following functions: registration of a new sample, presentation of the data on the monitor and/or printer, correction (addition) of the data, preparation of the index cards. The latter one is able to obtain a series of the data registered in every species when sample name (genus & species) is given. These functions described above are not yet completed but will be revised during actual use.

K. KURODA and K. SHIMAJI: **Wound Effects on Cytodifferentiation in Hardwood Xylem,** IAWA Bull. n.s., **6**, 107 (1985)

The wound effects on cytodifferentiation in hardwood xylem were studied by means of periodical observation of wound tissue formation after a pin insertion into

the stem of poplar. The mitotic reactivation of ray parenchyma cells was similar to that in conifers. These ray cell derivatives easily invaded other cells creating the impression of septate fibres. Conspicuous abnormalities were found in the differentiation of those fusiform cells which were situated in the zone of xylem mother cells at the time of wounding and those originating from cambial initials for several days after wounding. In the former zone, fusiform cells were prevented from differentiating into vessel elements after dividing transversely several times in the zone adjacent to the injury; fusiform cells in the area extending several millimetres longitudinally were variously modified morphologically after the frequent transverse divisions in the xylem mother cell zone: they showed various transitional patterns from vessel element-like through tracheid-like, and axial parenchyma-cell-like to fibre-like. These observations suggest that the direction of cytodifferentiation is determined in the cambial initials or the neighbouring xylem mother cells, and is controlled by certain substances, which may change in concentration through the wounding stimulus, bringing about the modification in cytodifferentiation. Wound reaction of hardwood (i.e., woody dicotyledons) was thus completely different from the regeneration of vascular system in injured herbaceous dicotyledons.

K. KURODA and K. SUZUKI: **Anatomical Studies on "Rooshi" Resinous Canker of Hinoki (*Chamaecyparis obtusa*)**, J. Jap. For. Soc., **67**, 63 (1985)

Tissue sections of Hinoki wood affected by "rooshi" resinous canker were examined, and the cause of such abnormal resin exudation was explored anatomically. Resin exudation was due to the numerous traumatic resin canals in the phloem which ranged tangentially and lied in concentric order at certain radial intervals. These resin canals continued active resin production for long periods. Stimuli that initiate such traumatic resin canals are the subject of a future study.

K. SHIMAJI (co-authored by H. Saiki and others): **Structure of Wood.** Bun-ei Do Pub. Co. (1985) (in Japanese)

Among ten chapters comprising the text book of wood structure for university classes, Chapt. I-A Wood (What is Wood?, Characteristics of Woody Plants, Position of Woody Plants in the Plant Kingdom), Chapt. IV Formation of Wood (Growth of Trees, Cambial activities) and Chapt. VIII Wood of Bamboos and palms were contributed by the author.

K. SHIMAJI, S. HAYASHI and S. FUKUDA: **Tree Species of Wooden Materials Excavated from Yotsuike Relics,** Educ. Committee of Sakai City ed., Report of Research on Cultural Properties in Sakai City, No. **16** "Yotsuike Relics", 200 (1984) (in Japanese)

6 wooden materials, more or less artificially processed, were excavated from

Yotsuike Relics (5th century) in Sakai city. Although some of them were supposed to be used for wooden plates and wooden tablets, the use of the others were not clear. Microscopic examinations revealed that tree species of these 6 wooden materials are all *Chamaecyparis obtusa.*

K. SHIMAJI: **Wood Biology — Today and Tomorrow —**, Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No. **19**, 20 (1984) (in Japanese)

The objectives of the Research Section of Wood Biology is to clarify the affecting factors and their influences on the qualitative and quantitative production of wood during every stage of wood formation, on the basis of wood anatomy. Research programs which are presently progressing are summarized as 1) Anatomical studies on wood quality, including the influence of forest tending techniques on the wood quality, and the relationship between crown growth and stem wood formation, 2) Physiological and anatomical studies on the wood formation, covering the differentiation of early and late wood; mechanism of compression wood formation; xylem differentiation in vitro; etc., 3) Ultrastructural and cytological studies of cell wall formation, including the biogenesis of cellulose microfibrils not only in higher plants but also in algae and bacteria for model system. The future vision of these research programs are mentioned with strong stresses on the need of mutual understanding or cooperations with forestry or forest science.

N. YOSHIZAWA, T. ITOH and K. SHIMAJI: **Helical Thickenings in Normal and Compression Wood of some Softwoods,** IAWA Bull. n.s., **6**, 131 (1985)

Compression wood in some softwoods having helical thickenings on the inner surface of normal wood tracheids were examined using a scanning electron microscope. Helical thickenings of *Taxus, Torreya* and *Cephalotaxus* have narrow bases, and are loosely attached to the innermost layer of the secondary wall, while those of *Pseudotsuga, Picea* and *Larix* have broad bases blended tightly with the microfibrils of the S_3 layer in normal wood. The transition from normal to compression wood entails a preservation of the thickenings in *Taxus, Torreya* and *Cephalotaxus,* while they are replaced by helical ridges and cavities in *Pseudotsuga, Picea* and *Larix.* The direction of helical thickenings gradually changes from an S- to a Z-helix, or a Z- to an S-helix in the course of the tranisition from normal to compression wood, or *vice versa* in *Taxus, Torreya* and *Cephalotaxus.* Helical checks never occur in these species. In *Pseudotsuga,* however, helical thickenings can be deposited as an additional layer on the helical ridges. The results obtained in the present investigation revealed that the orientation of the thickenings did not always coincide with that of the innermost microfibrils of the secondary wall layers, indicating that helical thickenings may be considered as a layer independent of the secondary wall.

J. AZUMA, T. NOMURA and T. KOSHIJIMA: **Lignin-Carbohydrate Complexes Containing Phenolic Acids Isolated from the Culms of Bamboo.** Agric. Biol. Chem., **49**, 2661 (1985)

Lignin-carbohydrate complexes containing phenolic acids (LCC-W) were isolated from Moso-bamboo *(Phyllostachys pubescens* Mazel) and characterized. LCC-W was separated into three fractions (W-1, 2, and 3) by gel filtration on Sepharose 4B. Of these three LCCs W-2 and W-3 were included in the gel matrices. W-2 consists of 34.7% neutral sugar, 1.6% uronic acid, 52.1% lignin, and 6.0% phenolic acid, and W-3, 67.9%, 3.6%, 22.3%, and 1.1%, respectively. Neutral sugar residues of W-2 and W-3 were mainly L-arabinose and D-xylose in the ratios of 5.5 : 94.3 in W-2, and 4.5 : 95.0 in W-3, respectively. Methylation, periodate degradation, and NMR analyses indicated that the carbohydrate moiety of LCC-W is composed of a linear backbone of β-(1→4)-linked D-xylopyranose residues with approximately every thirty residues carrying one 4-*O*-methyl-D-glucuronic acid and one or two arabinofuranose residues. Saponified phenolic acids were composed of *trans*-*p*-coumaric and *trans*-ferulic acids, which seems to be esterified to carbohydrate and lignin, respectively. Alkaline treatment, periodate degradation, and hydrophobic interaction chromatography suggested the presence of alkali labile and stable lignin-carbohydrate linkages.

J. AZUMA, N. TAKAHASHI, M. ISAKA and T. KOSHIJIMA: **Lignin-Carbohydrate Complexes Extracted with Aqueous Dioxane from Beech Wood.** Mokuzai Gakkaishi, **31**, 587 (1985)

Gel filtration of the lignin-carbohydrate complex isolated from beech wood *(Fagus crenata* Bl.) on Sepharose 4B was used to separate it into three fractions (W-1, 2, and 3) in which W-2 and W-3 are included in the gel. Composition of W-2 was 37.6% neutral sugar, 9.1% uronic acid, and 49.7% lignin, whereas the corresponding values for W-3 were 67.4%, 13.5%, and 9.9%, respectively. W-2 and W-3 contained L-rhamnose, L-arabinose, D-xylose, D-mannose, D-galactose, and D-glucose in the ratios of 2.3 : 4.8 : 82.9 : 2.1 : 5.1 : 2.8 and of 2.2 : 2.6 : 88.7 : 1.7 : 2.5 : 2.3, respectively. Methylation, Smith degradation, and NMR (nuclear magnetic resonance) spectroscopic analyses indicated that the backbone carbohydrate chain is β-(1→4)-linked D-xylan. Hydrophobic interaction chromatography on Phenyl- and Octyl-Sepharose CL-4B gels revealed that interaction acts between the aromatic ligands and the aromatic skeletons of lignin in the case of Phenyl-Sepharose, in addition to the hydrophobic interactions which operate exclusively in the case of Octyl-Sepharose. The results of alkaline treatment and periodate degradation indicated the presence of alkaline labile and stable linkages

between lignin and carbohydrate.

J. AZUMA and T. KOSHIJIMA: **Hydrophobic Chromatography of Pine Björkman-LCC.** Mokuzai Gakkaishi, **31**, 383 (1985)

Hydrophobic interaction chromatography on Phenyl- and Octyl-Sepharose gels was intended to compare the hydrophobicity of the two major parts of pine-wood Björkman LCC: C-I-M, the neutral fraction having a lignin content of 2.1%, and C-I-A, the acidic fraction having a lignin content of 6.1%. About 24% and 10% of C-I-M were adsorbed on Phenyl- and Octyl-Sepharose gels, respectively. For C-I-A these values were 33% and 68%. The adsorbed LCC was separted into subfractions on the basis of lignin content by stepwise elution with increasing concentrations of 2-ethoxyethanol and decreasing concentrations of ammonium sulfate. The results suggest that aromatic-aromatic interactions, together with hydrophobic interactions, contribute significantly to the bonds with Phenyl-Sepharose in contrast to Octyl-Sepharose in which hydrophobic interactions operated exclusively if the lignin content was high enough to interact completely with 1-octyl ligands.

T. WATANABE, J. AZUMA and T. KOSHIJIMA: **Isolation of Lignin-Carbohydrate Complex Fragments by Adsorption Chromatography.** Mokuzai Gakkaishi, **31**, 52 (1985)

A new method was presented for separation of lignin-carbohydrate complex fragments from large amount of oligosaccharides. The method comprized of enzymatic treatment of lignin-carbohydrate complexes followed by adsorption chromatography on Toyopearl HW40S. Lignin-carbohydrate complex oligomers adsorbed on this gel column could be desorbed by elution with 50% aqueous dioxane. The chemical properties of the lignin-carbohydrate complex fragments isolated from pine lignin-carbohydrate complexes were also presented.

J. AZUMA and T. KOSHIJIMA: **Microwave Irradiation of Lignocellulosic Materials III. Enzymatic Susceptibility of Microwave-irradiated Green Dried Wood Chips.** Mokuzai Kenkyu・Shiryo, **20**, 22 (1985)

Microwave heating of poplar green wood and dried wood chips was attempted in the presence of water to enhance the rates of enzymatic saccharification. The enzymatic susceptibility of all samples was markedly improved by microwave treatment carried out above 160°C. Wood chips had a similar saccharification rate to that with wood meal and did not show a maximum degree of saccharification below 240°C. The poplar green wood chips as well as beech dried wood chips were resistant to enzymatic saccharification but their enzymatic susceptibility could be improved to the same order as in wood meal by increasing the temperature up to 240–260°C. The present results demonstrated that microwave heating is a useful

pretreatment method for enzymatic saccharification of wood chips.

J. AZUMA, J. HIGASHINO, M. ISAKA and T. KOSHIJIMA: **Microwave Irradiation of Lignocellulosic Materials IV. Enhancement of Enzymatic Susceptibility of Microwave-irradiated Softwoods.** Wood Res., **71**, 13 (1985)

Effect of microwave irradiation on the enzymatic susceptibility of various softwoods was investigated. The pH values of the reaction liquor dropped with increasing temperature to 2.9–3.3 at 230°C, consistent with increase in acidity (0.5–0.85 meq at 230–239°C). Above approximately 180°C, hemicellulose underwent acid-mediated autohydrolysis and became water-soluble yielding a mixture of oligosaccharides and monosaccharides. The maximum extents of saccharification below 240°C ranged between 36–62% for softwoods, while those for hardwoods were between 88–93%. The present investigation confirmed that microwave pretreatment enhanced the enzymatic susceptibility of various softwoods.

E. MAEKAWA and T. KOSHIJIMA: **Properties of 2,3-Dicarboxy Cellulose Combined with Various Metallic Ions,** J. Appl. Polymer Sci., **29**, 2289 (1984)

2,3-Dicarboxy cellulose and partially oxidized 2,3-dicarboxy cellulose were prepared in good yields from the corresponding dialdehyde cellulose obtained by periodate oxidation of cellulose according to a modification of the method described by Hofreiter, Wolff, and Mehltretter [*J. Am. Chem. Soc.*, **79**, 6457 (1957)[. The 2,3-dicarboxy cellulose oxidized to nearly 100% oxidation level was completely soluble in water, but the 2,3-dicarboxy cellulose of 70% oxidation level was not. The former 2,3-dicarboxy cellulose took up various metallic ions other than alkali metals to form a precipitate or solid. The metal contents taken up corresponded to the theoretical values calculated as combined in the form of metallic salt of the carboxylic acid group. 2,3-Dicarboxy cellulose combined with metallic ions such as copper, cobalt, and nickel ions gave viscous, gel-like products, which solidified when exposed to air. The properties of products combined with such metallic ions are discussed.

E. MAEKAWA: **Cellulose Derivatives and its Utilization — On the Derivatives from Dialdehyde Cellulose** — Kobunshi Kako, **33** (6), 298 (1984) (in Japanese)

The derivatives from dialdehyde cellulose obtained by periodate oxidation of cellulose were reviewed.

E. MAEKAWA: **The Description of my Experience during Research abroad in Arrhenius Laboratory of Stockholm University,** New Lumber Man, **15**, 1 (1985) (in Japanese)

The experience duting research abroad in Arrhenius Laboratoy was described,

including the introduction of Arrhenius Laboratory, the research activities, and the life of Swedish people.

S. FUJISHIMA, F. YAKU, and T. KOSHIJIMA: **Recovery and Reutilization of Cellulases Used for the Hydrolysis of Wood I. Fundamentals,** Mokuzai Gakkaishi, **30**, 560 (1984)

To investigate the recovery of cellulases used for the hydrolysis of woods, it is necessary to know the behavior of the cellulases during the hydrolysis.

We developed a method to determine the quantity of enzyme from the spectrum of circular dichroism of cellulase without interference due to coexisting lignin and saccharides in solution.

Cellulase Onozuka R-10 from *Trichoderma viride* and Cellulosin AC from *Aspergillus niger* were used for the enzymatic degradation of Akamatsu *(Pinus densiflora* S. and Z.) and their properties were investigated. Cellulase Onozuka R-10 had an intense affinity with wood, and 50% of the enzyme added to the reaction system was adsorbed by the wood powder after 30 minutes, and which still kept its activity in the adsorbed state. In contrast with Cellulase Onozuka R-10, Cellulosin AC had little affinity with wood powder and activity remaining in the solution was twice as high as that remaining in the residual wood after enzymatic hydrolysis for 24 hours. The activity remaing in the solution decreased with an increase in reaction time and a decrease in pH of the solution.

S. FUJISHIMA, F. YAKU, and T. KOSHIJIMA: **Recovery and Reutilization of Cellulases Used for the Hydrolysis of Woods II. Stability of Cellulases,** Mokuzai Gakkaishi, **31**, 280 (1984)

The stability of Cellulase Onozuka R-10 from *Trichoderma viride* and Cellulosin AP from *Aspergillus niger* and their mixture were studied. The two cellulases were almost stable when their solutions were allowed to stand at 40°C without shaking. The inactivation of Cellulosin AP with shaking was greater than that of Cellulase Onozuka R-10, especially the inactivation of endo-β-1, 4-glucanase of Cellulosin AP which was significant. Inactivation of mixed cellulases was the average of that of each cellulase. The effects of shaking rate, ratio of volume of the solution to the vessel, enzyme concentration, temperature, and pH on the inactivation of the enzymes were investigated. From the results, the conditions to obtain the highest ratio of degradation of wood polysaccharides and in the recovery of cellulases are discussed.

E. MURAKI, F. YAKU, and T. KOSHIJIMA: **Enzymatic Degradation of Finely-Divided Wood Meal III. Lauans,** Mokuzai Gakkaishi, **30**, 936 (1984)

In investigating the effect of milling on the enzymatic saccharification of lauan woods the saccharification ratio after ball-milling for three hours and hydrolyzing

at pH 4.0 was only 10–20%. This value was much lower than that of Akamatsu which was ball-milled and hydrolyzed under the same conditions. With a 2.5 times greater concentration of exzyme and a pH 4.5 however, the saccharification ratio increased to about the same value as for Akamatsu. Under these conditions, yellow lauan was hydrolyzed to about 55% of the wood (about 90% of wood polysaccharide), and red lauan was hydrolyzed to about 40% of the wood (about 70% of wood polysaccharide). Milling for one to three hours was sufficient to obtain a high saccharification ratio for both yellow and red lauans when the concentration of enzyme was appropriately selected, depending on the wood species.

T. HIGUCHI: **Biosynthesis and Biodegradation of Wood Componets,** (Academic Press, Orland, FL), (1985)

22 review articles concerning biosynthesis and biodegradation of wood compondedts were edited.

T. HIGUCHI: **Degradative Pathways of Lignin Model Compounds,** In, "Biosynthesis and biodegradation of wood components", ed., T. Higuchi (Academic Press, Orlando, FL), pp.557–578 (1985)

Recent advances in lignin biodegradation research using lignin substructure model oligomers were discussed intensively.

T. HABE, M. SHIMADA, T. OKAMOTO, B. PANIJPAN and T. HIGUCHI: **Incorporation of Dioxygen into the Hydroxylated Product during the C-C Single Bond Cleavage of 1, 2-bis (*p*-methoxyphenyl)propane-1, 3-diol Catalysed by Hemin. A Novel Model System for the Hemoprotein Ligninase,** J. Chem. Soc. Chem. Commun., **1985**, 1323

Oxdiation of the lignin model compound 1, 2-bis(*p*-methoxyphenyl)propane-1, 3-diol catalysed by hemin in the presence of t-butyl hydroperoxide and $^{18}O_2$ yielded p-methoxyphenylethane-1, 2-diol with 83% ^{18}O incorporation into the newly formed hydroxy group and *p*-anisaldehyde as the initial C_α-C_β bond cleavage products.

T. OKAMOTO, K. SASAKI, M. SHIMADA and S. OKA: **Catalysis of Aerobic C-C Bond Cleavage of 1, 2-bis (4-methoxyphenyl) Ethane-1, 2-diol by *meso*-tetraphenylporphyrinatoiron (III). A Model System for Cytochrome P450$_{scc}$-dependent Glycol Cleavage,** J. Chem. Soc. Chem. Commun., **1985**, 381

Catalytic cleavage of 1, 2-bis (4-methoxyphenyl) ethane-1, 2-diol by chloro (*meso*-tetraphenylporphyrinato) iron (III) in the presence of *N*-benzyl-3-carbamolyl-1, 4-dihydropyridine under molecular oxygen at room temperature yielded exclusively 4-methoxybenzaldehyde, reproducing most features of the C-C bond cleavage of a vicinal diol catalysed by cytochrome P-450$_{scc}$.

T. HABE, M. SHIMADA and T. HIGUCHI: **Biomimetic Approach to Lignin Degradation I. H_2O_2-dependent C-C Bond Cleavage of the Lignin Model Compounds with a Natural Iron Porphyrin and Imidazole Complex,** Mokuzai Gakkaishi, **31**, 54 (1985)

Hydroperoxide-dependent C-C bond cleavage of the lignin model compounds were studied by use of biomimetic prophyrin catalysts. Catalytic oxidation of dianysilpropane-1, 3-diol (β-1) lignin model compound yielded *p*-anisaldehyde as a major product accompanied by other cleaved products in smaller amounts. Addition of imidazole in the reaction mixture enhanced the reaction rate. A β-O-4 lignin model compound (4-ethoxy-3-methoxyphenyglycerol-β-guaiacyl ether) also underwent oxidative C-C bond cleavage yielding 4-*O*-ethylvanillic acid as a predominant product. Among the various porphyrins tested, iron-porphyrins including phthalocyanin were the most effective for the cleavage reaction.

T. Kent KIRK and M. SHIMADA: **Lignin Biodegradation: The Micro-Organisms Involved and the Physiology and Biochemistry of Degradation by White-rot fungi,** In, "Biosynthesis and biodegradation of wood components", ed., T. Higuchi (Academic Press, Orlando, FL), pp. 579–605 (1985)

Lignin biodegradation research was reviewed on the following points. a) The microbiology of lignin degradation by white-rot fungi b) lignin degradation as a secondary metabolic event, c) molelular oxygen as a regulatory agent, d) induction of the ligninolytic system, e) active oxygen species as ligninolytic agents, f) lignin-degrading enzyme.

S. KAWAI, T. UMEZAWA and T. HIGUCHI: **Metabolism of a Non-phenolic *β-O*-4 Lignin Substructure Model Compound by *Coriolus versicolor*,** Agric. Biol. Chem., **49**, 2325 (1985)

A non-phenolic β-*O*-4 substructure model, 4-ethoxy-3-methoxyphenylglycerol-β-syringaldehyde ether (I), was metabolized by a ligninolytic culture of *Coriolus versicolor*. Based on the identification of the metabolic products (II-XI), the following reactions were found to occur in the culture; a) oxidation (III) and reduction (II) at the benzyl ($C_{\alpha'}$) position of the substrate (I), b) β-ether cleavage to give arylglycerols (IV, V), and c) C_α-C_β cleavage of the arylglycerols and/or arylglycerol moiety of the substrate (I). In addition, β-deoxy diol (VI) and γ-formylglycerol (VII) were obtained as degradation products from substrate (I).

T. UMEZAWA and T. HIGUCHI: **Role of Guaiacol in the Degradation of Arylglycerol-β-guaiacyl ether by *Phanerochaete chrysosporium*,** FEMS Microbiol. Lett., **26**, 123 (1985)

It was found that guaiacol and 4-ethoxy-3-methoxyphenylglycerol were produced

via different pathways and that they were not counterpart compounds to each other in the cleavage of the β-O-4 bond of 4-ethoxy-3-methoxyphenylglycerol-β-guaiacyl ether by a white-rot fungus, *Phanerochaete chrysosporium.*

T. UMEZAWA and T. HIGUCHI: **Aromatic Ring Cleavage in Degradation of β-O-4 Lignin Substructure by *Phanerochaete chrysosporium*,** FEBS Lett., **182**, 257 (1985)

The degradation of a β-O-4 lignin substucture model dimer, 4-ethoxy-3-methoxyphenylglycerol-β-guaiacyl ether (I), by the white-rot fungus *Phanerochaete chrysosporium* was investigated. The guaiacyl aromatic ring of the dimer (I) was first cleaved to give the cyclic carbonate of 4-ethoxy-3-methoxyphenylglycerol (II) which was then converted to 4-ethoxy-3-methoxyphenylglycerol (III). The carbonate carbon of (II) was found to be derived from the guaiacyl group of (I) based on tracer experiments with ^{13}C.

A. SATO, K. FUSHIKI and Y. OHTA: **Discoloration of Kiri Wood (*Paulounia* sp.) and Its Chemical Treatment,** Wood Preservation, **11**, 25 (1985)

Short story about utilization of Kiri wood is introduced with tables and graphs, and reddish change for plywood is discussed as a trouble which appears between some extractives and the glues for plywood. Bleaching effects using by chemicals and the results of g.l.c. on extractives were discussed with experiments.

M. TANAHASHI and T. HIGUCHI: **Steam Explosion Process for Wood and its Development** Japan TAPPI (Kamipa Gikyoushi) **39**, 118 (1985)

Steam explosion process for wood is an efficient pretreatment method for wood refinary. The present paper discussed on the physical and chemical characteristics of exploded wood, and efficient utilization of easily separated components from the exploded wood. Future development of the steam explosion process of wood was also discussed in relation to pulping, wood saccharification, productions of cattle feed and wood plastics.

M. TANAHASHI and T. HIGUCHI: **Deveropment of Continuous Steam Expolsion Technique and its Applications,** Kamiparupu Gijutsu Taimusu, **28**(8), 1 (1985)

An example for the operation of continuous steam explosion process in Takara Shuzo Co. Ltd. was put for attention. Steam explosion process was efficient pretreatment for wood and its probable applications for cattle feads preparation, saccharification and alcohol fermentation process, pulping process and utilization of residual lignins were interpretated.

S.V. Lonikar, N. Shiraishi, T. Yokota, M. Tanahashi and T. Higuchi: **Effect of the Explosion Pretreatment on the Thermal Softening and Melting of Esterified Wood,** Journal of Wood Chemistry and Technology, **5**, 111–133 (1985)

The explosion treatment has been used with the objective of increasing the accessibility of wood. After the explosion treatment wood meal was esterified. Acyl groups introduced were acetyl, caproyl and lauroyl. Caproylation was carried out by three different methods—PCA catalyst method, TFAA catalyst method and DMF/PY/acid chloride method. The PCA catalyst method was not used for lauroylation since it is not an effective procedure for introducing higher acyl groups. The DMF/PY/acid chloride method could not be used successfully for acetylation. Thermal softening and apparent melting behaviour of the exploded-esterified wood meal was studied by following the collapse of a column of powder under a constant load in a glass capillary tube 3 mm in diameter at a programmed rate of heating.

Samples exploded at various conditions and esterified by the DMF/PY/acid chloride method showed thermal flow in nearly the same temperature range. The thermal flow was observed at considerably lower temperature for the corresponding samples acylated by TFAA catalyst method. Also, the thermal softening or apparent melting temperature (flow temperature) of the samples acylated by TFAA method was found to be dependent on the condition of explosion. The more severe the explosion treatment, the lower was the flow temperature. In other words, an increase in the explosion temperature or duration at a particular temperature resulted in a decrease in the thermal softening or melting temperature. This fact has been attributed to the loosening of wood texture in combination with the action of trifluoroacetic acid (TFA) formed during the acylation by the TFAA method.

The larger the size of the acyl group introduced, the lower the flow temperature became.

S.V. Lonikar, N. Shiraishi, T. Yokota, M. Tanahashi and T. Higuchi: **Effect of the Loosening of Wood Texture on the Mercerization of Cellulose in Wood,** Journal of Wood Chemistry and Technology, **4**, 483–496 (1984)

When wood was treated with 23% aqueous sodium hydroxide followed by washing with water and drying, no lattice conversion of cellulose was observed under the experimental conditions employed. On the other hand, wood subjected to a pretreatment that results in the loosening of its morphological texture, upon mercerization, showed a varying degree of lattice conversion. The explosion process and the TFA (trifluoroacetic acid) treatment were used to achieve the loosening of wood texture. The lattice conversion of cellulose was studied by X-ray diffractograms. The extent of lattice conversion was found to depend on the conditions

of the pretreatment used to achieve the loosening of wood texture. The extent of lattice conversion increased with an increase in the explosion temperature and the time at temperature, within the range of these experiments. Increased duration of TFA pretreatment, at a particular temperature, resulted in a higher degree of lattice conversion. These observed facts have been ascribed to the extent of loosening of the morphological texture of wood, which allows comparatively free swelling of cellulose in alkali.

T. MIYAMOTO, Y. SATO, T. SHIBATA, M. TANAHASHI and H. INAGAKI: **^{13}C-NMR Spectral Studies on the Distribution of Substituents in Water-Soluble Cellulose Acetate,** Journal of Polymer Science: Polymer Chemistry Edition, **23**, 1373 (1985)

The degree of substitution (DS) and distribution of O-acetyl groups of water-soluble cellulose acetate (CA) were investigated by ^{13}C-NMR. For this purpose, three different seies of CA samples with low DS were prepared by respective homogenous reaction, i.e., (1) deacetylation of cellulose triacetate (CTA) in acetic acid-water solution (D-series), (2) reaction of CTA with hydrazine (H-series), and (3) acetylation of cellulose with acetic anhydride in a 10% LiCl-dimethylacetamide solution (A-series). It was found that (i) water-soluble CA can be obtained only from D-series products, (ii) the DS value of water-soluble CA ranges from 0.5 to 1.1, (iii) the D-series products exhibit little difference between the relative DS values at C-2, C-3 and C-6 hydroxyl groups, and (iv) the relative DS at C-6 hydroxyl groups is very high compared to those at C-2 and C-3 hydroxyl groups in H- and A-series products. Aqueous solution of water-soluble CA (D-series sample) showed no gel-sol transition, even when the temperature was raised to 95°C. X-ray diffraction observations revealed that the water-soluble D-series samples were essentially noncrystalline, but the water-insoluble A-series smaples were crystalline. It was also found that the relative ease of acetylation is C-6>C-2>C-3.

T. MIYAMOTO, Y. SATO, T. SHIBATA, H. INAGAKI and M. TANAHASHI: **^{13}C Nuclear Magnetic Resonance Studies of Cellulose Acetate,** Journal of Polymer Science: Polymer Chemistry Edition, **22**, 2363 (1984)

^{13}C-NMR spectra of ring carbons and O-acetyl carbonyl carbons of cellulose acetate (CA) in dimethyl sulfoxide-d_6 were analyzed. The CA samples with the degree of substitution (DS) ranging from 0.84 and 1.91 were prepared by homogeneous acetylation of cellulose with acetic anhydride in a 10% LiCl/dimethyl acetamide solvent. It was found that the use of these low-DS samples permitted easier assignments not only of the ring carbon but also of the O-acetyl carbonyl carbon signals. The assignments were confirmed by comparing with the ^{1}H-NMR spectra of the

samples obtained by complete acetylation of the corresponding CA samples with acetyl-d_3 chloride. Two methods for determining the distribution of O-acetyl groups of CA, i.e., the relative DS at the three different types of hydroxyl groups, were developed. One is based on the measurements of the relative intensities of the signals for the ring carbons and the other is based on the measurements of the relative intensities of the signals for the O-acetyl carbonyl carbons.

M. NORIMOTO: **Wood Bending Utilizing Microwave Heating,** Mokuzai Kogyo (Wood Industry), **39**, 319 (1984) (in Japanese)

Wood bending utilizing microwave heating was reviewed.

T. ONO and M. NORIMOTO: **On Physical Criteria for the Selection of Wood for Soundboards of Musical Instruments,** Rheologica Acta, **23**, 652 (1984)

In order to develop criteria for the physical evaluation of wood for soundboards of musical instruments, measurements were made of dynamic Young's modulus E', static Young's modulus E, internal friction Q^{-1} in longitudinal direction, and specific gravity γ for numerous species of broad-leaved wood. From the results obtained, including those of our previous paper on coniferous wood, it was found that the suitability of wood for soundboards could be evaluated by the quantity of $Q^{-1}/(E'/\gamma)$, and that there were very high correlations between $Q^{-1}/(E'/\gamma)$ and E'/γ, and between E' and E, regardless of wood species. Consequently, it becomes possible to select practically any wood suitable for soundboards by using the value of E/γ, which can be measured easily, and it was derived that the relation between E'/γ and Q^{-1} of wood could be expressed by an exponential equation regardless of wood species.

T. OHGAMA and M. NORIMOTO: **Elastic Constants of Wood Cell Wall,** The Bulletin of the Faculty of Education, Chiba University, **33**, Part II, 127 (1984) (in Japanese)

The Young's modulus of the cell wall in longitudinal direction was theoretically estimated using a cell-wall model, in which the distribution of chemical constituents and microfibril angles in the cell-wall layers are taken into account. The effects of crystallinity, microfibril angle, fraction of S_2 layer and elastic constants of matrix on Young's modulus of the cell wall was estimated according to this theory.

K. MINATO and M. NORIMOTO: **Moisture Adsorption Characteristics and the Dimensional Stabiliazation Mechanism of Paper and Wood Cross-Linked by Formaldehyde,** Mokuzai Gakkaishi, **31**, 209 (1985)

Hailwood-Horrobin's adsorption equation was applied to the moisture adsorption isotherms determined for formaldehyde cross-linked filter paper and wood. In their hteory, overall adsorbed water is assumed to consist of hydrated water and dissolved water. For both paper and wood specimens treated in vapor phase, the

dissolved water decreased with increasing reduction in swelling. On the other hand, the amount of hydrated water was independent of the reduction in swelling for paper, whereas it decreased with the increasing reduction in swelling for wood. The fiber saturation point, estimated by extrapolating the isotherm to 100% RH, decreased with increases of the reduction in swelling, but the point was considerably smaller than that obtained by the nonsolvent water method at various dimensional stability levels. For the paper specimens treated in the liquid phase process, the moisture adsorption behavior appeared specific; the equilibrium moisture ontent of treated specimens was higher than in the untreated specimens. The mechanism for the dimensional stabilization was inferred as follows. In paper, the expansion of the fiber network, which occurs when the paper is soaked in water, is restricted by the formation of formaldehyde cross-linkages. This results predominantly in anti-swelling efficiency. In wood, the decrease of adsorption sites for water molecules contributes mainly to dimensional stability.

T. ONO and M. NORIMOTO: **Anisotropy of Dynamic Young's Modulus and Internal Friction in Wood,** Japanese J. Appl. Phys., **24**, 960 (1985)

The dynamic Young's modulus E and the internal friction Q^{-1} in three principal directions were measured from the longitudinal vibration in several species of soft-wood and hardwood. The modulus E in the radial (R) and tangential (T) directions was much lower than that in the longitudinal (L) direction regardless of the wood species, and the order of magnitude was $E_l \gg E_r > E_t$, whereas the friction Q^{-1} showed exactly the opposite tendency, i.e., $Q_l^{-1} \gg Q_r^{-1} > Q_t^{-1}$. An investigation of the relationship between the values showed that the internal friction could be expressed by an exponential equation of the specific Young's modulus E/γ regardless of the direction and wood species, and that the exponent in three principal directions was slightly lower than that in the L direction. Furthermore, the differences in the values (E and Q^{-1}) and exponents between directions were considered from the structural aspect, and it was found that the causes were the same and could be explained well by the difference in the structural factors.

T. MOROOKA, M. NORIMOTO, T. YAMADA, and N. SHIRAISHI: **Direlctric Properties of Cellulose Acylates,** J. Appl. Poly. Sci., **29**, 3981 (1984)

Thirteen kinds of cellulose acylates from the acetate to stearate were prepared by trifluoro acetic anhydride-fatty acid esterification, and their dielectric constant and loss were measured over wide temperature and frequency ranges. Two types of relaxation process (α_d and β_d) were recognized for all the acylates and an additional relaxation process (γ_d) was detected for the acylates with side chain length longer than that of the butyrate. These α_d to γ_d processes were attributed to the micro-

Brownian motion of the main chain (α_d), the motion of oxycarbonyl group of the side chain (β_d) and the motion initiated by minimum three methylene groups in addition to the oxycarbonyl group (γ_d), respectivly. In the transition map for the β_d process, inflection points were observed, and the temperature at the inflection point could be regarded as a freezing point of the micro-Brownian motion of the acyl side chain. In the temperature region above the inflection point, plots in transition map for all the acylates were found to be on the same straight line.

H. YANO and T. YAMADA: **Study on the Timbre of Wood I. Sound Spectrum of Wood in the Radial Direction,** Mokuzai Gakkaishi, **31**, 719 (1985) (in Japanese)

To characterize the timbre of wood, sound spectra of clamped-free beams of 41 wood specimens of 19 species, aluminum, steel, stainless steel, and acrylic resin were investigated. The spectra were determined by the Sinewave Sweep Excitation method in the range from 500 Hz to 20000 Hz in a conditioned anechoic room (20°C, 65% RH). Wood specimens were 200 mm (R) × 20 mm (L) × 3 mm (T). The results were as follows:

(1) Peak levels of sound spectra of wood specimens decreased linearly with increasing frequency, whereas that of metal specimens remained almost constant up to 10000 Hz.

(2) Both the total number of peaks and the slope of the spectrum envelope of wood (α) in the range examined were found to vary with the species. An analysis based on the Timoshenko theory suggests that the causes of these differences were due to the differences in the value of $E_R/\kappa G_{RT}$ which is a measure of share of shear in the deflection of specimens.

H. YANO and T. YAMADA: **The Dynamic Mechanical-Properties of Wood in the Radial Direction,** Mokuzai Gakkaishi, **31**, 222 (1985) (in Japanese)

In this study, the dynamic mechanical-properties of softwoods and hardwoods in the radial direction were investigated. Measurements were made of 160 specimerns of 28 species, 11 softwood and 17 hardwood species. Flexual Young's modulus, E_R, logarithmic decrement, $\lambda_{B(R)}$, torsional shear moduli G_{RL}, G_{RT} and logarithmic decrements, $\lambda_{T(RL)}$, $\lambda_{T(RT)}$, were obtained at 20°C and 65% R.H.

Results were as follows:

(1) The values of moduli, the order being $E_R > G_{RL} > G_{RT}$ for both softwoods and hardwoods, increased linearly with specific gravity.

(2) There was a linear relationship between E_R and G_{RL}, G_{RL} and G_{RT}, and G_{RT} and E_R and their correlation coefficients for hardwoods was very large.

(3) Since the ratio E_R/G_{RT} decreased with increases of specific gravity (Fig. 6), the influence of shear on deflection of beams decreased with increasing specific gravity.

(4) For both softwoods, and hardwoods, the values of logarithmic decrement were in the order of $\lambda_{T(RT)} > \lambda_{B(R)} > \lambda_{T(RL)}$, and those of the latter increased with increasing percentages of rays.

(5) There was a linear relationship between $\lambda_{B(R)}$ and $\lambda_{T(RL)}$, $\lambda_{T(RL)}$ and $\lambda_{T(RT)}$, and $\lambda_{T(RT)}$ and $\lambda_{B(R)}$.

S. ISHIHARA: **Fire Endurance of Wooden Panels 2. Fire Endurance of the Joints of Wooden Panels.** Moruzai Kenkyu Shiryo (Wood Research and Notes). No.20, 87 (1985) (in Japanese)

To serve as basis for establishing acceptance criteria for structural wooden wall panels, fire endurance tests were done and discussed on the wooden panels jointed with 15 kinds of the joints and glued with 12 kinds of the adhesives by means of JIS A 1304.

S. ISHIHARA: **Effects of Wood Species, Particle Size, Specific Gravity and Thickness of Board, and Fire Retardant Treatments on the Fire Endurance of Particleboards.** Zairyo, **34**, 959 (1985) (in Japanese)

Particleboards were manufactured with five species and eleven sized particles, and fire resistant particleboards were also manufactured with phosphoric acid-melamine-formaldehyde condensation products (A) and urea-melamine-formaldehyde resin glue (B) containing H_3BO_3, $Na_2B_8O_{18}\cdot 4H_2O$ and NaBr as fire retardants. The effects of species, particle size, specific gravity and thickness of the board, fire retardant treatments and kinds of the fire retardant chemicals on the fire endurance of the boards were investigated by means of the JIS A 1304. The effect of species on the fire endurance of the boards was very slight. Increasing particle size, specific gravity and thickness of the board resulted in an effective increase in the fire endurance of the boards. A and B glue imparted excellent fire resistance to the board. Increase of the fire retardant glue content in the board and of $[H_3PO_4]/[M]$ molar ratio in A glue improved the fire endurance of the boards. Coating of phosphoric acid-melamine-formaldehyde condensation products on the board surface gave the best fire resistance to the boards.

S. ISHIHAR4 and S. KONDO: **Fire Performance, Physical and Mechanical Properties of Fire-Resistant Three Layered Particleboards.** Zairyo, **34**, 966 (1985) (in Japanese)

Three layered fire-resistant particleboards were manufactured with adhesives containing fire-retardant chemicals. Fire endurance, physical and mechanical properties of the boards were determined and discussed. The fire-retardant chemicals used were H_3BO_3, KOH, $LiOH\cdot H_2O$, $Na_2B_8O_{13}\cdot 4H_2O$, NaOH, and NaBr and the adhesive was a commercial urea-melamine-formaldehyde resin. The fire-retardant

adhesive containing H_3BO_3 was stabilized by the addition of alkali metal compounds. The fire-retardant adhesives imparted excellent fire resistant to the three layered particleboard. All of the 22 mm thick three layered particleboards and the full scale one glued with the fire-retardant adhesives successfully met the acceptance fire penetration criteria under the standard fire test for 30 minutes rating of class B wall of INTERNATIONAL CONFERENCE ON SAFTEY OF LIFE AT SEA 1960. Excepting a few fire-resistant particleboards, the basic engineering properties of the 22 mm thick three layered fire-resistant particleboards were better than or equivalant to those of the commercial fire-resistant particleboards and the untreated commercial ones.

S. ISHIHARA: **Combustions of Wood and Wood-based Materials and their Controls by Chemical Treatments** (**1**), Kobunshikako (Polymer Application), **34**, 302 (1985), (**2**), *ibid*, **34**, 356 (1985), (**3**), *ibid*, **34**, 406 (1985), (**4**), *ibid*, **34**, 516 (1985)

M. NAKAJI, S. KAWAI and S. MORITA: **Water Registance of Light-weight Board,** Mokuzai Hozon (Wood Preservation), **26**, 53 (1985) (in Japanese)

Light-weight particleboard bonded with an isocyanate compounds adhesive was newly developed. The fundamental physical and mechanical properties of the boards with the density range of 0.3–0.5 g/cm^3 were summerized and the water registance of the boards were investigated in detail. The results showed that light-weight board had high water resistivity, i.e., high dimensional stability both in the plan and in the thickness directions.

S.P. TAKINO, H. SASAKI and S. KAWAI: **Structural Properties of Sugi from the Shikoku Districts,** Mokuzai Kenkyu Shiryo (Wood Research and Technical Nptes) No.20, 78 (1985) (in Japanese)

Structural properties of Sugi from the Shikoku districts for structural use are discrived.

H. SASAKI: **Wood-Based Panels in the Future,** Mokuzai-Hozon, **26** (1) 3 (1985)

Production trends of wood-based panels in these ten years were reviewed and the remarkable increase of particleboard production was pointed out. Attention was made on the oriented thin particleboards and the low-density thin particleboards to be improtant panels for structural use in the future. The condition of the substitution of particleboards for plywoods in Japan was discussed.

S. KATO and H. SASAKI: **LVL Plant for Utilizing the Domestic Softwoods** Mokuzai-Kougyou, **40**, (6) 38 (1985)

Problems encountered when converting small diameter logs from the domestic softwood plantation, especially thinnings, into structural LVLs were discussed. A plant newly constructed in Gifu prefecture was introduced as an example of the utilization of thinnings. The venner lathe in the plant has three powered back-up rolls which have been developed by the author. Logs are peeled to the final core diameter of 50 mm. MUF resin is used for the structural purpose. Radio frequency heating is applied simultaneously in the pressing by hot-platens. The capacity is around 20 m^3/day.

H. SASAKI and S. KAWAI: **Low-Density Particleboard with Isocyanate Adhesive,** Proc. For. Prod. Res. International (Pretoria Symposium), **6**, 9–3 (1985)

Low-density particleboards with density 0.3–0.4 g/cm^3 were prepared by using an unemulsified isocyanate adhesive under various conditions: The variation of density profile through the thickness of board was made by taking different combinations of the two-steps hot-pressing, and the orientation of particles was made on some boards by an electrostatic method. Particleboards having higher density gradient through the thickness showed more thickness swelling and less mechanical properties than those of the particleboards with uniform density profile. By the orientation of particles, the bending properties were much improved in the oriented direction.

M. TAKATANI, R. HAMADA and H. SASAKI: **Cleavage Fracture of Wood-Epoxy Resin Bond Specimens in Long-Term Loading I,** Mokuzai Gakkaishi, **31**, (8), 675 (1985)

The characteristics of cleavage fracture under long-term loading were examined on double cantilever-beam type wood-epoxy-resin bond specimens with a range of glue-line thicknesses of 0.1–1.5 mm at practical temperatures (30°C–60°C).

The results are summarized as follows: 1) At low test-temperatures (30°C, 40°C) concave-shaped endurance curves were obtained, whereas at high test-temperatures (50°C, 60°C) convex-shaped endurance curves were obtained. These variation in shape of the curves might be explained by the differences in the stress concentrations at the crack tip prepared in the glue-line of the specimens.
2) It seemed that the endurance-limit stress increased with decreasing test-temperatures, and the highest value was obtained at a thickness of 0.75 mm.
3) In general, when the load level was high and the time to failure was short, a mixture of wood failure and adhesive failure was observed, whereas with a low load and a long time to failure the adhesive failure was dominant.

M. TAKATANI, R. HAMADA and H. SASAKI: **Cleavage Fracture of Wood-Epoxy Resin Bond Specimens in Long-Term Lading II,** Mokuzai Gakkaishi **31**, (9), 746 (1985)

Fracture toughness at the endurance limit load under a long-term loading was defined. It was supposed that G_{Id} could be calculated by the following equation:

$G_{Id}=G_{Ic}(P_{Id}/P_{Ic})^2$

where P_{Ic} and G_{Ic} are the fracture load and the fracture toughness in static test, respectively, and P_{Id} is the endurance limit load under a long-term loading.

G_{Id} of various wood-glue bond specimens were calculated by this equation. It seemed that the cleavage fracture toughness at the endurance limit (G_{Id}) of wood-epoxy-resin bond spcimen tended to have a peak at 40°C and increased as increasing the thickness of glue line.

Observation of the opening displacement of loading and the propagation of cracks suggested that the visible crack propagation might occur when the work done by a given load after loading reached a certain amount, and the amount of work increased with increasing test temperature and glue line thikness.

K. NISHIMOTO, Y. IMAMURA, A. ADACHI and A. SATO: **Decay and Termite Resistance of Hinoki (*Chamaecyparis obtusa* ENDL.) from Different Forestations,** Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No.20, 104 (1985) (in Japanese)

Hinoki (*Chamaecyparis obtusa* ENDL.), which is an important reforestation species the same as Sugi, has been used in high quality items in Japanese buildings. Laboratory decay and termite tests were conducted to determine the reliability of those resistance of Hinoki wood from a natural and three different forests.

Hinoki wood was shown to be comprehensively more resistant to decay and termite attack than Western hemlock and Japanese Beech, which were of poor durability and were used for test controls, however, heartwood as well as sapwood was moderately infested in some cases. Results gave evidence leading to doubt about the accuracy of the tentative durability previously ascribed to the species.

K. NISHIMOTO and Y. IMAMURA: **Physical and Protective Properties of Particleboards Made by Mixture of Acetylated and Normal Chips,** Mokuzai Kogyo (Wood Industry), **40**, 414 (1985) (in Japanese)

Particleboards with a target density of 0.65 in oven-dry were made by mixture of untreated chips of Spruce (*Picea jezoencis* CARR.) with acetylated ones (about 17 percent weight gain) on various ratios of blending. The mixture ratios of acetylated chips were 0, 25, 50, 75 and 100 percent as weight proportion. The boords were bonded with three types of adhesives of urea-melamine formaldehyde (UMF),

phenol-melamine formaldehyde (PMF) and isocyanate (Is) resins at 8 percent content based on weight of the chips, respectively.

Board qualities of internal bond strength (IB) and thickness swelling (TS) were measured according to JIS A 5908, and decay resistance was detected through soil-block tests by *Tyromyces palustris* and *Coriolus versicolor* as described in JWPA designation. In general, the mixture of acetylated chips reduced IB of test boards and the values decreased remarkably when bonded with UMF and PMF, but Is held relatively high glutability eventhough the ratio of acetylated chips accounted 100 percent. There was a trend of decreasing values of TS and water absorption (WA) after soaking in water for 24 hours, as the amount of acetylated chips increased, and the fully acetylated boards exhibited 2 to 3 percent of TS, and WA value below 20 percent. The equilibium moisture content of the acetylated boards in air-dry condition was reduced to the range of 3 to 5 percent, and that under moisture-saturated condition was below 10 percent.

The rate of decay was very slow in the boards containing up to 50 percent acetylated chips causing reduced weight losses, and the specimens containing 100 percent of acetylated chips showed no sign of decay. Though the weight losses by feeding were not so large as controls, the termites of *Coptotermes formosanus* were able to attack the test boards of higher amount of acetylated chips, on the other hand, the boards of 75 percent acetylated chips could be hardly infested by the other kind of termites, *Reticulitermes speratus*.

K. NISHIMOTO: **Termiticidal Effectivenes of Tripropyl Isocyanulate,** Kankyo Kanri Gijutsu (Jour. Environ. Control Tech.), **3**, 421 (1985) (in Japanese)

A new low-toxicity chemical, tripropyl isocyanulate is outlined from the aspects of termite control, covering physical and chemical characteristics, biocidal activity toxicology, stability and termiticidal activity. The chemical gave promising results as an alternative termiticide. That was environmentaly acceptable and showed good efficacy against termites as contact-poison, stomach-poison and repellent agent.

Y. NAKAMURA and K. NISHIMOTO: **Incising Force of a Knife Edge into Wood I—Incision with Oyster Type Knife Edge,** Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No. 20, 42 (1985) (in Japanese)

Incising force was investigated with a small oyster type knife edge, using eight wood species including a few impermeable ones which must be incised. Influence of incised surfaces (tangential or radial), incising angles to fiber axis and incision depths on incising force was discussed here and following results were obtained.

(1) With the increase in incising angles up to 90°, incising force per width unit of the knife edge (mm) tended to increase in both tangential and radial surfaces.

(2) Incising force increased linearly with incision depths in using an oyster type knife edge, which was quite different from the behaviour in incising force changes obtained by a double edged chisel.

(3) The incising force changes, especially in the tangential surfaces, were charaterized by the width of late wood of each wood species, and classified into four types according to wave patterns (*e.g.* calms, ripples, wavelets and surges) of figures showing the relation between incising force and incision depths.

(4) Correlation between incising force in both tangential and radial surfaces and specific gravity of wood seemingly existed. However, as to Beimatsu and Karamatsu with high specific gravity, the decrease in incising stresses was accompanied with the occurrence of cracks in the woods when larger incising angles to fiber axis were employed in the tangential surface. The result suggested that any correlation between incising force and specific gravity could not be perceived with those timber species at larger incising angles (above 60°).

(5) In the case of radial surface incision, slopes of the regression equations were indicative of a good correlation with specific gravity of wood.

K. NISHIMOTO: **Biology of Termites-Protozoa associated with Termites and Their Role in Digestion,** Kankyo Kanri Gijutsu (Jour. Environ. Control Tech.), **2**, 12 (1984) (in Japanese)

Epitomized translation of chapter 1-Protozoa associated with termites and their role in digestion of the book, "Biology of Termites (Vol. 1)" edited by K. Krishna and F.M. Weesner, on the species of protozoa found in the digestive organs of termites, the role of them in the digestion of wood and so forth.

K. NISHIMOTO: **Biology of Termites-Flight and Colony Foundation,** Kankyo Kanri Gijutsu (Jour. of Environ. Control Tech.), **2**, 164, 224, 315 (1984) (in Japanese)

A series of the epitomized Japanese translations of chapter 8-flight and colony foundation of the book, "Biology of Termites (vol. 1) are concerned mainly with the activity of termites in their colony before swarming and the relationship between the flight acrivity of temites and environmental factors (temperature, humidity, rainfall, wind, atmospheric pressure, etc.).

M. TAKAHASHI and K. NISHIMOTO: **Method for Testing Effects of Fungicides by Soil Treatment against *Serpula lacrymans* (1) Determination of Medium and Comparison of Fungi-Static Effects between Several Fungicides,** Mokuzai Kenkyu Shiryo (Wood Research and Technical Notes), No.20, 31 (1985) (in Japanese)

A laboratory method was designed for testing effects of fugicides by soil treat-

ment against a dry rot fungus *Serpula lacrymans* (WULFEN ex FRIES) SCHROETER. Fungal activity was compared between the twelve different media each containing yezo spruce (*Picea jezoensis* CARR.) wood meal and/or the nutrient solution (peptone 1% and malt 2% extract) as their nutrient sources. The following medium was employed for the method: Kanuma-soil (4–20 mesh) 250 g, spruce wood meal 20 g and the nutrient solution 81 ml. Kanuma-soil as a bedding material is composed of silica and alumina with different particle sizes. This is widely used for horticulture and easily purchasable.

Fungicide-treated soil layer with 3 cm-thickness was made contact with fungal mycelium growing on the above-mentioned medium. Effect of fungicide was evaluated by the development of mycelium onto upper surface area of the treated layer and the yezo spruce wood blocks, and by the resulting weight loss of blocks due to decay. The following three fungicides were able to inhibit completely the mycelial development at lower retention level (0.010～0.019 a.i.kg/m^3): tributyltinoxide, tolclohosmethyl, and 4-chlorophenyl-3′-iodo-propagylformal.

The method is worthy of consideration for evaluating the effectiveness of fungicides for soil treatment against *S. lacrymans*.

M. TAKAHASHI and K. NISHIMOTO: **Improved Techniques Designed for Evaluation of Fungicides in Soil for Control of Dry Rot Fungus *Serpula lacrymans*,** International Research Group on Wood Preservation, Documents No. IRG/WP/2238, (1985)

Improved techniques provide a laboratory method for the evaluation of chemicals in soil for control of dry rot fungus *Serpula lacrymans*. Results with their application to three chemicals were reported.

Non-weathered treated layers were able to inhibit completely the mycelial development of *S. lacrymans* at retentions of 0.038 kg/m^3 for chemical A (4-chlorophenyl-3-iodopropagylformal), 0.019 kg/m^3 for B (tributyltinoxide) and 0.075 kg/m^3 for C (tolclofosmethyl), respectively. Dry-heat weathering reduced slightly the effectiveness of chemical C at the lower retention tested (0.019 kg/m^3). On the other hand, wet heating caused the significant reduced effect on all chemicals used, at both retentions for A, and at the lower retention for B and C, respectively.

These techniques are useful to eliminate chemicals lacking the necessary toxicity and weatherbility for dry rot control when the chemicals have been applied to the soil.

A. ENOKI, M. TAKAHASHI, H. TANAKA and G. FUSE: **Degradation of Lignin-Related Compounds and Wood Componets by White-Rot and Brown-Rot Fungi,** Mokuzai Gakkaishi, **31**, 397 (1985)

The metabolism of lignin-model compounds and wood components by ten spe-

cies of white-rot fungi and eleven species of brown-rot fungi was investigated using low-nitrogen media to examine the relevance of their degrading systems on ligninmodel compounds to their actual ligninolytic systems. Stationary-liquid and agarplate culture conditions were employed to study the effect of cultural conditions on their degrading abilities of substrates. Three dimers with different types of linkages, 4-ethoxy-3-methoxyphenylglycerol-β-guaiacyl ether (I), 1-(3′4′-dimethoxyphenyl)-1,3-dihydroxy-2-(4″-methoxyphenyl) propane (II), and dihydroanisoin (III) were used as simple lignin-model compounds.

Most of the white-rot fungi could degrade all three dimers at various rates under liquid and agar conditions or only under agar conditions, whereas the majority of the brown-rot fungishowed no or very-poor activity against all three of the dimers under both cultural conditions. However, four brown-rot species, *Laetiporus sulphureus, Lentinus lepideus, Gloeophyllum trabeum,* and *Pholiota adiposa* showed low but distinct activity against one or two compounds under liquid conditions. Higher activites were demonstrated under agar conditions by these species except for *L. sulphureus,* especially by *G. trabeum.* Such enhancement of activity was recognized also in some white-rot species. Furthermore, it was proved that the three dimers were always degraded more rapidly and beech wood-blocks were always decayed more severely under agar conditions. Therefore, agar-culture conditions are considered to be more suitable than liquid culture conditions for the investigation of lignin biodegradation.

White-rot fungi which were highly active against the three dimers under agar conditions also could degrade the lignin and cellulose components in beech wood under the same conditions. The ratios of % lignin loss and % cellulose loss to % weight loss were about 1.0 in these decayed blocks. Of the five brown-rot fungi which caused large weight losses in beech wood under agar conditions, *Tyromyces palustris, Daedalea dickinsii, Spongiporus sinuosus,* and *L. sulphureus* caused distinct losses of lignin in beech wood (% lignin loss/% weight loss=about 0.4), although they showed no or very little activity against all three dimers. Another fungus *G. trabeum* with great degrading ability against these dimers produced a higher loss of lignin than those by the former species (% lingin loss/% weight loss=0.6).

In identification and determination of the metabolites from the three dimers during the degradation by the four white-rot fungi, several products which also were found in the metabolic pathways in a white-rot fungus, *Phanerochaete chrysosporium,* were detected with similar yields. In the brown-rot fungi that showed limited or distinct activity against the three dimers, none of these products were found. Taking this together with other results, degrading systems of these dimers and ligninolytic systems in brown-rot fungi are considered to be quite different from those in white-rot fungi.

M. TAKAHASHI: **Biodeterioration of Plywood and Board Materials,** Mokuzai Hozon (Wood Preservation), No.26, 22 (1985) (in Japanese)

Decay- and termite resistance of plywood and board materials is much influenced by amount and type of adhesive, maufacturing condition, density of material and surface properties. Natural resistance of wood species does not cause a significant effect on the resistance of these materials. Attack in surface layer of plywood is of importance because the symmetry between the center of section as amerit of plywood is lost. A rapid decrease of strength occurs in particle board during early stage of decay. This is due to active fungal invasion onto the surface of particles and consequent glue failures.

M. TAKAHASHI: **Treatment and Preservatives for Control of Decay and Wood-Damaging Insects,** In "New Technical Processess in Forest Products Industry", ed. by Japan Wood Research Society, 54, pp.226 (1985) (in Japanese)

Preservative treatments of building timbers and wood-based composites are described. Current and promissing wood preservatives are also described.

K. TSUNODA and K. NISHIMOTO: **Laboratory Evaluation of Organophosphates as Termiticides,** The Int. Res. Group on Wood Pres., Document No. IRG/WP/3330 (1985)

In accordance with Japan Wood Preserving Association Standard 11(1) laboratory evaluations of five organophosphate insecticides and chlordane were conducted.

Superficially treated sapwood of *Pinus densiflora* Sieb. et Zucc. ($10\times10\times20$ mm) was compulsorily exposed to the attacks of 150 workers and 15 soldiers of *Coptotermes formosanus* Shiraki for 21 days at 28 ± 2°C in the dark. Percentage weight loss of the wood blocks was determined at the end of the test. Termite mortality was additionally calculated at regular intervals.

Of five organophosphate insecticides evaluated, chlorpyrifos and phoxim were the most effective and were followed by acephate and tetrachlorvinphos. Required treating concentrations were $<0.1\%$ for chlorpyrifos, phoxim and tetrachlorovinphos, 0.1–0.2% for acephate and 0.2–0.4% for fenitrothion. For chlordane 0.5–1.0% was desired.

Results based on the percentage weight loss indicated that organophosphates were generally more effective than chlordane in controlling termites. It is, therefore, worthy to take up potential chemicals for further investigation.

K. TSUNODA: **Improvement of Preservative Effectiveness by Glue-line Additive,** Mokuzai Hozon (Wood Preservation), No.26, 32 (1985) (in Japanese)

Glue-line additive treatment of plywood and particleboard is reviewed with 30 references. Effectiveness of the treatment was not satisfactory for plywood, while

promising results were obtained for particleboard and fiberboard. Further development on low-toxicity preservatives might unable to protect board materials from the attack of decay fungi.

H. Doki, K. Tsunoda and K. Nishimoto: **Effect of Juvenile Hormone Analogues on Caste-differntiation of the Termite, *Reticulitermes speratus* (Kolbe) (Isoptera: Rhinotermitidae),** Material u. Organismen, **19**, 175 (1984)

Four juvenile hormone analogues (JHA) were tested for their ability to induce caste differentiation of workers and nymphs of *Reticulitermes speratus* (Kolbe) when 50 individuals (30 in some cases) were exposed to JHA-treated filter paper placed in glass Petri dishes at 26°±1°C for 4 weeks. The number of individuals developing into presoldiers, soldiers and supplementary reproductives was determined by daily observations. The number of dead termites was concurrently recorded. Ethyl[2-(p-phenoxy phenoxy)ethyl] carbamate was by far the most effective, and gave promising results as an alternative termiticide. The JHA succeeded in causing differentiation with a peak at a treating level of 0.08 mg/dish: about 70% of workers molted into presoldiers. In the presence of the JHA nymphs developed into presoldiers more easily than workers. The maximum rate of differentiation was obtained at 0.008 mg/dish in similar tests. The mortality of the termites rose with increasing doses of the JHA. The other 3 JHA's also produced a high mortality of the wor,ers, but one of them had only very slight effects on caste differentiation with little interesting phenomena for further research.

Y. Imamura and K. Nishimoto: **Bending Creep Test of Wood-Based Materials under Fungal Attack,** Zairyo (J. Soc. of Material Science, Japan), **34**, 985 (1985) (in Japanese)

A testing method coupled with bending deformation and decay hazard was newly designed to evaluate mechanical performance of wood-based materials under fungal decay, and it was applied to plywood and particleboard as well as solid wood. The test specimens measuring 50×350 mm×(thickness) were subjected to bending creep tests under progressive fungal attack with a brown-rot fungus [*Tyromyces palustris* (Berk. et Curt) Murr.] and a white-rot fungus [*Coriolus versicolor* (L. ex Fr.) Quél.] in the decay apparatus. After fixation of loading, the deflection at the center of the span length (300 mm) was measured regularly as a criterion to determine its expected performance.

The difference in deflection between the inoculated specimen and the sterile sound control one was assumed to be due to strength reduction caused by the action of fungi, and the behavior of bending deformation varied depending on the durability of the specimens.

The method was shown to be particularly useful for the study of particleboard degradation in which high strength loss and large deflection in bending were oxcasionally observed at slight weight loss. It can be generally applied not only to ubtreated materials for estimation of their mechanical resistance to decay fungi, but also to treated ones for determination of their preservative efficacy.

M. SAKAMOTO and K. SUMIYA: **Some Fundamental Problems on Measurements of the Bioelectrical Potential of Poplar (*Populus nigra* L.) Callus,** Mokuzai Gakkaishi, **31**, 620 (1985)

Some fundamental problems on the measurements of the bioelectrical potential of poplar (*Populus nigra* L.) callus by the microelectrode method were considered. It was shown that it would be best to use 1 mM or less concentrations of phosphate solutions as the buffers in the measurements of the potential. It also was shown that the potential was lowered in the acidic pH region. In the range of over 1 mM concentration of inorganic cations, the potentials decreased in accordance with the NERNST equation. This suggested that these cations should be transported passively at their high concentrations. The response of callus was peculiar only to K^+ in the low concentrations of 1 mM or less, reflecting a living state and the ability of selective transportation cations in the poplar callus. The potential change was observed clearly by the addition of non-electrolyte, sugars. This change was the hyperpolarization which clarified to be a living responte of poplar callus.